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Climate of the Past Discussions

Interactive comment on "Late Pliocene and early Pleistocene environments of the north-eastern Russian Arctic inferred from the Lake El'gygytgyn pollen record" *by* A. A. Andreev et al.

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Response to Anonymous Referee #1 Interactive comment on "Late Pliocene and early Pleistocene environments of the north-eastern Russian Arctic inferred from the Lake El'gygytgyn pollen record" by A.A. Andreev et al. Received and published: 28 November 2013

*This paper, focussed on the vegetation changes in Russia during the Pliocene and early Pleistocene, presents highly reliable data on the Lake El'gygytgyn that surely need to be published. In fact, authors show here an impressive long pollen record (750 samples) that represents without doubt an exceptional source of information for the

scientific community. Topics of the paper enter well in general themes of Climate of the past.*

We are grateful to reviewer for high evaluation of our work and valuable suggestions helping to improve our paper.

This paper is very interesting although amendments need to be done before publication: - In the introduction, I rather wanted to find a more detailed presentation of the context. It has been done for the spatial context but not really for what is interesting to do in the region on the studied period proposed comparing to what has been already done in other part of the world. The quick summary proposed in the introduction about what has been done on the cores will be consistent for a special paragraph that may be useful for the discussion at the end of the paper. In fact, at the end of the introduction, we have the feeling that we have to read all what has been done previously on the lake before beginning to read the paper. What is called multiproxy in the paper? I have only seen a large palynological (pollen and non-pollen palynomorphs) results that compare pollen, algae, spore and fongi. When I had finished reading the introduction, I imagined that the paper will compare vegetation with data from sedimentology, lake level and so on: : :.. A rapid look on the figures shows that it is not the case. Why? Probably other data are available on this core and may be useful for the interpretations.

We will work on the introduction to improve it according to the comment. However, it is not non-expectable that you have mostly seen a large palynological (pollen and non-pollen- palynomorphs) results. The manuscript was titled Late Pliocene and early Pleistocene environments of the north-eastern Russian Arctic inferred from the Lake El'gygytgyn pollen record, so we use pollen, algae, spore and fungi to reconstruct the environment. Nevertheless we decide to change the title of the manuscript to Late Pliocene and early Pleistocene vegetation history of the north-eastern Russian Arctic inferred from the Lake El'gygytgyn pollen record. The new title will better fit the manuscript content.

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For the sedimentological and geochemical results please see other papers of the special issue (namely Pliocene to Pleistocene climate and environmental history of Lake El'gygytgyn, Far East Russian Arctic, based on high-resolution inorganic geochemistry data by V. Wennrich et al., 2013 and for the overview please see Brigham-Grette et al., 2013 in Science.

- Another remark concerns the chronological framework of the studied series. I understand that the proposed paper correspond to one of a collection of papers on the same site (it is largely written in the introduction and after). However, the paper must be readable alone without searching after all the other papers written on the cores. We definitively need a paragraph on the chronology to understand how the series have been dated and how the age model has been constructed. A figure that replaces the core in the known chronology of the studied period with the proxy that have help to construct the age model will be very helpful and especially in front of the record of Liesecki and Raymo for example. In fact, authors do not mentioned the geological periods by reference to the classic geological time scale in the text and in the figure.

The special paragraph on the chronology will be added. Age Model Dating of the ICDP-Site 5011-1 sedimentary composite record is based on magnetic polarity stratigraphy (Haltia & Nowaczyk, 2013, this issue) and by cyclostratigraphy of various climatically controlled sedimentological and geochemical parameters. Initial tie points for the age model were derived from major geomagnetic reversals back to the early Gauss chron, documented in the cores. The radiometric age of the El'gygytgyn impact at 3.58±0.04 Ma (Layer 2000) provided another initial tie point. Fine-tuning of data sequences on biogenic silica, total organic carbon (TOC), tree and shrub pollen percentages, grain size analyses, sediment color, Si/Ti ratio obtained from X-ray fluorescence (XRF) scanning, magnetic susceptibility to both the marine oxygen isotope stack (LR04) of Lisiecki & Raymo (2005) and the Northern hemisphere summer insolation provided by Laskar et at. (2004) provided a total of about 600 tie points of the final age model. For further details see Nowaczyk et al. (2013, this issue).

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The mentioned MIS according Lisiecki and Raymo are added in the upgraded figures as well.

- Part 2: The method is well- explained. Nevertheless, I would like to have a recall about the composition of the biomes that will be used in the paper. Probably it will be also helpful to non palynologists not to only refer to the paper of Tarasov et al.

The palynologists also have to read carefully about the biomization method to understand how it can be used to help the understanding of environmental changes. However, a paper focused to compositions of the revealed biomes as well as other questions concerning the biomization method written by Tarasov et al. (2013) is a part of this special issue and very easy available for the interested readers. So, it is probably no needs to duplicate the methodological other questions concerning the biomization in our paper once more. The main focus of our paper is vegetation history based on the pollen record, but not the results of biomization.

- Part 3: o Description of the pollen record is too long in my opinion. In parallel, the diagrams are difficult to read as they are very little especially concerning the labelling of the pollen zones (PZ). Reader has to enlarge the diagram with an important magnification to be able to read them.

We agree that description of pollen zones is long, however, we are tried our best to keep the description as short as possible. Please take in consideration that we are describing the exceptionally long pollen record dated between 3.58 and 2.15 Ma. In other word we have an almost 1.5 Ma record with about 940 samples studied now for pollen and non-pollen-palynomorphs which were combined in 58 pollen zones reflecting changes in vegetation cover and climate. Such description is very important as it provides a basis for reconstructions and discussions presented in this special issue and, therefore cannot be excluded from the manuscript. Moreover, it is possible that the data will be interesting for further use by different researchers therefore they have to be properly presented.

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* o Description pollen zone by pollen zone results in a boring part in the paper: five pages and half even if it remains interesting for the specialist. Is it possible to synthetize this part? To make it more attractive I propose to place the complete pollen data in additional files and to present a simplified pollen diagram by gathering the taxa (main and sporadic ones) in groups that eventually mimics the following biomes presented after. This will feature the changes that occurred in the record. It will be helpful if authors show in the same figure a comparison with the reference climate curve such as Lisiecki and Raymo one with the classic chronology (here, Pliocene – Piasanzian, Pleistocene – Gelasian).*

Actually, this part is already synthesis and pollen taxa on figures 3a and 3c are the only main taxa. Please take in consideration that we have synthetized here the changes in pollen record which happened during almost 1.5 Ma. And the record reflects numerous changes of the vegetation from dark coniferous spruce-pine-fir forests to treeless steppe and tundra like habitats. The pollen data presented in the manuscript are the basis of the biome and climate reconstructions presented in papers by Brigham-Grette et al. (2013) in Science and Tarasov et al. (2013), this issue. However, complete pollen data are not properly published until now. So, the main aim of the manuscript is to make these pollen records and pollen inferred vegetation reconstruction available for the broad audience dealing with environmental changes in the past. The results of biomization method are well presented in Tarasov et al. (2013) is a part of this special issue and very easy available for the interested readers. So, there is probably no need to duplicate it in the manuscript focused on the changes in vegetation cover reflected in pollen record. For the details concerning the biome reconstructions please also see Tarasov et al., (2013) this issue. Moreover the reconstructed biomes are present in Fig. 6.

*o Fig. 5 is particularly difficult to read. Perhaps, authors may circle the taxa that allow defining the main vegetation groups that drive the changes and the position of the different pollen zones as indicated in the text. This figure will then appear clearer

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to the reader. Explanations are in the short paragraph 3.2 and the three sentences at the end of this paragraph are not demonstrated by what has been write before. I do not see exactly the aim of that.*

We will follow the recommendation in order to make the figure and text clearer to the reader.

- Interpretation and discussion: o This part has been cut in several paragraphs that do not represent any geological basis. Is this cutting corresponded to anything in the sedimentology??? It will support the interpretations if the figures show the magnetic chronology and if the geological stages are mentioned in front of the data.

Yes, this part represents the interpretation of revealed changes in the pollen spectra, but not the changes in the sedimentology and local geology. Surely, the changes in the pollen spectra are reflecting the climate fluctuations which also may correspond to changes in the lake sedimentology however this is not always so clearly and directly reflected in the sedimentology and local geology. However, our manuscript is focused in changes in regional vegetation inferred from the pollen spectra. For the changes in the sedimentology please see other papers from the special issue (namely V. Wennrich et al.). The mentioned geological stages are now in front of the pollen data in the upgraded pollen diagram (Fig 3).

Here again the text must be synthetized as for the descriptive part. The reader runs to read that and that's a pity because these impressive data are here embedded. Lot of questions are opened when regarding this pollen record.

Actually, this part is the interpretation of the revealed pollen data. Of cause the reader has to read our paleoenvironmental reconstructions and interpretations in order to be able to evaluate them. And it is also normal if some questions regarding this pollen record remain open. We are not pretending that we answered all questions. However, it is very important to properly and completely present the obtain results which may serve as a basis for further studies and maybe for interpretations different from ours.

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This is a main aim of our paper.

o Probably it would have been better to extract only the main trends and changes in vegetation and compare with the general pattern of climate cyclicity : first the predominance of 19-21 kyrs cycles prior to 2,58 Ma and then the occurrence of the 41 kyrs cycles after 2,58 Ma. In lake El'gygytgyn, is there different pattern prior and after 2,58 Ma that points to the Pliocene/Pleistocene boundary? There are few episodes of cold steppe developments just around this date. Does it correspond to that transition?

Generally, the main aim of the manuscript is reconstruct the main trends and changes in vegetation. However, we cannot ignore other possible minor trends and changes. Concerning the climate cyclicity: in our opinion the climate cyclicity which might be inferred based on our pollen record looks the opposite: the predominance of the more or less 41 kyrs cycles before 2.58 Ma and then the occurrence of ca 20 kyrs cycles after. However, if you look carefully to the revealed alternation of periods with dry and cold conditions and periods with more favorite climate you may notice that these cycles more likely 10-12 kyrs. Nevertheless, we agree that study of climate cyclicity changes is very important. However, we simply cannot solve all appearing questions in one publication. Moreover, as a next step of our pollen studies is much higher resolution for the interval 2.7-2.5 Ma which should help to understand the changes happening during the Pliocene/Pleistocene transition. When this work will be completed it will be a material for the next publication where we will pay a special attention to the climate cyclicity changes.

o Is it possible in this record to detect the different cyclicities and to define a pattern for the response of the arctic vegetation to these climate oscillations? If the cycles are really recorded, can we see repetitive successions signing these cycles as it has been evidenced in other regions?

For better understanding and correct interpretation of the different cyclicities recorded in the El'gygytgyn pollen record in order to define the responses of the arctic vegetation

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we need first to complete the palynological study of the upper (Pleistocene) part of the sediment cores. However, this work is still in the progress at the moment.

o Do the authors try to place their record in front of the climate record of Lisiecki and Raymo? Some of the isotope stages are cited. Why the authors do not present the figure with the comparison:

It is done for the upgraded figure 3.

o When I have a rapid look to the pollen diagram, I see a regular alternation of the taxa - conifers peaks versus Betula ones for example - that may correspond to cyclic features. This may be shown in a simplified diagram or through the biomes representation. In conclusion, this paper present data of great importance that deserves publication after the proposed amendments.

Such simplified interpretation through the biomes representation is present on Figure 6. Please see also for details Tarasov et al (2013) this issue.

Response to Anonymous Referee #2 Interactive comment on “Late Pliocene and early Pleistocene environments of the north-eastern Russian Arctic inferred from the Lake El’gygytgyn pollen record” by A. A. Andreev et al. Received and published: 6 December 2013

The manuscript presents an exhaustive set of pollen data from the Plio-Pleistocene of Lake El’gygytgyn. The data are of high quality and of extremely high scientific value as they provide unique information on past vegetation and climate conditions from a well dated sequence of northwest North America.

Thank you very much for high evaluation of our work and valuable suggestions helping to improve our paper. Only a small remark – the sequence is from extreme northeastern part of Northern Eurasia.

*The manuscript is dealing mostly with pollen data providing detail information on the assemblages and related vegetation on regional scale. Quantitative interpretation in

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terms of climate conditions is, however, presented in a very general manner. Similarly, comparison with other Pliocene climate records is too general to be really informative. More insight into climate estimates and their uncertainties in terms of winter vs. summer temperature and precipitation would be useful for paleoclimatologists.*

We will pay especial attention in the upgraded manuscript to provide more details. However, such detailed insight into climate estimates and their uncertainties are well presented by Tarasov et al. (2013) this issue and Brigham-Grette et al. (2013) in Science. We tried to avoid the duplication the well published and well discussed data in our manuscript. Please, take into the consideration that the main focus of this manuscript is vegetation changes but not the climate ones. The title of in the upgraded manuscript is changed now to better reflect the manuscript content.

Beyond these general considerations, some questions or suggestions are made below. In the introduction, there is reference to temperature changes relative to present, but there is no description of the present day context. The modern settings (climate parameters and vegetation) of the study area need to be presented. In particular, what is the modern vegetation and climate?

The modern settings including climate parameters and vegetation patterns are well discussed in other papers of this special issue, in particular in Andreev et al. 2012, Lozhkin and Anderson, 2013, and Tarasov et al. 2013 thus it seems that we have to repeat it here again. In this publication we focus mainly on the vegetation changes during 3.58-2.15 Ma and tried to avoid duplication of the modern settings data presented and discussed in other papers of the special issue in details. However, the modern settings (climate parameters and vegetation) of the study area can be presented in this paper again as well.

Does the temperature increase of 2°C the Arctic since 1961, which is mentioned in reference to IPCC, applies to the Lake El'gygytgyn area? In the difference between paleo- and modern temperatures, is thiis 2°C taken into account or not?

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Reference climate variables attributed to the modern pollen samples used in the modern analogue based climate reconstructions for Lake El'gygytgyn had been derived from New et al. global dataset, which represents modern climate averages over the time interval from 1961 to 1990. For the details please see Tarasov et al. (2013) this issue and Brigham-Grette et al. (2013) in Science.

Betula and Alnus are indicated to be shrub pollen taxa at many places in the text. However, Alnus is presented as tree taxa in some sections referring to macrofossil remains. This needs to be clarified.

Please clarify what sections do you mean, do our manuscript refer to these sections? It will help to answer your question. Basically, it is possible to subdivide pollen of the Betula into Betula section Albae-type and Betula section Nanae-type as well as pollen of Alnus into Alnus fruticosa-type and Alnus sp. by use of special pollen atlases and papers (please see Blackmore at al. 2003). But please take in account that pollen types are not the same as plants and potentially could be produced by different species. When we are taking about the shrub pollen taxa we mean Betula section Nanae-type for shrub birch and Alnus fruticosa-type for shrub alder. We will check the manuscript to make it clear for the reader.

In any case, the authors should explain how they differentiate trees from shrub based on the pollen grains.

It is not the easy question to answer: Do the pollen was produced by trees or shrubs. However it is possible to subdivide pollen of the Betula into Betula section Albae-type and Betula section Nanae-type as well as pollen of Alnus into Alnus fruticosa-type and Alnus sp. by use of special pollen atlases and papers (please see Blackmore at al. 2003). But please take in account that pollen types are not the same as plants and potentially could be produced by different species. However, it seems that we do not state that we can differentiate trees from shrub based on the pollen grains it in the text of the manuscript. At least we could not fine it. Please provide the reference to

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manuscript page where we state it.

*It would be very helpful to illustrate the location of sites referred to in the text. In the comparisons, reference to climate estimates from the Canadian Arctic and Greenland sites (e.g., Csank et al., Bennike et al.) would be relevant. *

Do you mean to add an extra map with the location of sites referred to in the text? It is possible however taking in consideration the possible scale of such map where we should put the location of sites in Chukotka, Lake Baikal, a number of sites in Canadian Arctic and Greenland sites would be it really helpful especially taking in consideration that a number of close situated sites will be overlapped? Basically these locations are rather known and we refer to them. However, we can provide such map if necessary

Similarly, some comments about the biome reconstructions by Salzmann et al. would have been useful for the reader.

What comments about the biome reconstructions by Salzmann et al do you mean? Should we in our manuscript try to comment the biome reconstructions by Salzmann et al 2013 or do you mean something else? Please clarify; it will help to reply to your comment correctly. And any way our manuscript is focusing to the vegetation changes inferred the pollen records, but not on the methodological questions concerning the biome reconstructions and discordance revealed by data-models comparisons by Salzmann et al. 2013. Such methodological questions and discordances revealed by data-models comparisons have to be additionally studied and discussed by a multidisciplinary team of specialists including modelers (similar as was done by Salzmann et al. 2013), but they are not directly relevant to the vegetation history of the northeastern Russian Arctic inferred from the El'gygytgyn pollen record.

In figure 3a, the concentration units are missing. Were pollen fluxes calculated? They could provide useful information on pollen production, and possibly distal atmospheric transport?

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Pollen influxes were not calculated for this study. They might in dead provide some information on pollen productivity and possible distal atmospheric transport however it was not a goal of the study and have to be studied additionally. There are a lot of questions arising during this study. However, it is not possible to discuss all of them in one publication. Moreover, it is planned that these questions will additionally be studied when the palynological study of the upper (Pleistocene) part of the sediment cores will be completed. However, this work is still in the progress at the moment.

Inferences about water level or humidity are made based on Sphagnum, Pediastrum and other palynomorphs. Are there other tracers, sedimentological, geochemical or isotopic, that could document the water level? Would it be possible to develop a humidity-precipitation index?

Sure, there are other tracers that reflect changes in water level, but their correct interpretation as well as possible development of a humidity-precipitation index is a special task which is not intended to be done in this study. The main focus of our manuscript is vegetation changes reflected in pollen spectra.

When presenting temperature reconstructions, it would be useful to give the absolute values in addition to the anomaly and to provide indication about the variability and uncertainty of the signal. Similarly, when possible, it would be relevant to discuss the seasonality (winter vs. summer temperature) and precipitation.

For questions concerning temperature reconstructions, variability and uncertainty of the temperature signal etc. please see Tarasov et al. (2013) in this issue and Brigham-Grette et al. (2013) in Science, where such questions are additionally discussed. Again, the main focus of our manuscript is vegetation changes reflected in pollen spectra. We will certainly continue to improve climate reconstructions based on the El'gygytgyn pollen record; however such study will be conducted when the palynological study of the upper (Pleistocene) part of the sediment cores will be completed. This work is still in the progress at the moment.

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Pollen preservation is discussed but the preservation criteria are not mentioned.

What preservation criteria do you mean exactly? Do we discuss it in our manuscript? Generally, pollen preservation was very good and about the same through the studied slices of the sediment cores.

What about the pollen taxonomy? Is it exactly the same than the modern one?

What do you mean about the pollen taxonomy? To identify found pollen grains we use pollen atlases and papers describing modern pollen and dealing with modern pollen taxonomy. Basically all found fossil pollen taxa are the same as modern one. It is possible that some pollen types were produced by extincted plant taxa which were close-related to the modern ones. However, it is not possible to identify on pollen morphological level. Any way it is very unlikely that pollen types were produced by extincted plant taxa and even if we would have such pollen it could not have a visible effect on vegetation reconstruction.

Was Sciadopitys pollen observed?

Yes, single Sciadopitys pollen grains were observed twice in the sediments dated about 3.05 and 2.8 Ma. However it is very unlikely that the taxa grew near the lake. We assume that it is long distance transported pollen grains.

The pollen data are clearly unique. Hence the resolution of analyses should permit to discuss the climate stability, instability and rapidity of the transitions. To document this would add value to the manuscript. In brief, the data sound excellent but their climate significance could be more explicitly presented.

Thank you very much for the high evaluation of our data. However, the climate reconstruction is a special task. For details concerning climate reconstructions, climate stability, instability and rapidity of the transitions please see Tarasov et al. (2013) in this issue and Brigham-Grette et al. (2013) in Science. We will certainly continue to improve climate reconstructions based on the El'gygytgyn pollen record including climate

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stability, instability and rapidity of the transitions however such study will be conducted further when the palynological study of the upper (Pleistocene) part of the sediment cores will be completed. This work is still in the progress at the moment.

Response to B Fréchette (Referee) Interactive comment on "Late Pliocene and early Pleistocene environments of the north-eastern Russian Arctic inferred from the Lake El'gygytgyn pollen record" by A. A. Andreev et al. Received and published: 9 January 2014

*With the interest I read the paper "Late Pliocene and early Pleistocene environments of the north-eastern Russian Arctic inferred from the Lake El'gygytgyn pollen record" written by A.A. Andreev et al. (CP-2013-112). The paper is very interesting and as anonymous referees 1 and 2 I believe that it is suitable for publication in Climate of the Past. The pollen stratigraphy presented is very impressive (750 samples!) and supplements very well other results available on the same core. Results presented are of extremely high scientific value. At present, the manuscript requires moderate/minor modifications before it can be accepted. The text is on my opinion too descriptive and needs to be summarized and some figures need to be clarified. All my comments are described below. GENERAL COMMENTS: The manuscript presents late Pliocene and early Pleistocene (ca. 3.58-2.15 Myr) pollen assemblages from a NE Russian Arctic lake (Lake El'gygytgyn) sediment core covering the last 3.6 Myr. The pollen record is segmented in 53 pollen assemblage zones (PZ). Pollen assemblage from ca. 3.6 to ca. 2.6 Myr are dominated by tree taxa whereas those from ca. 2.6 to ca. 2.2 Myr are rather dominated by herb and shrub taxa. Environmental conditions (vegetation and climate) through late Pliocene and early Pleistocene are discussed in light of the pollen content. Environmental changes reconstructed are compared with the Marine Isotope Stage (MIS) and other records. The pollen record presented in the current paper have been used to reconstruct biome (Tarasov et al., 2013) and climate (Melles et al., 2012; Brigham-Grette et al., 2013). The publication of the late Pliocene/early Pleistocene pollen results here is very important notably because it will help us to best understand

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published biome and climate reconstruction results. Collectively, these papers move a step forward our knowledges on the relationship between pollen, vegetation and climate variability.*

We are glad that you find our paper very interesting and suitable for publication in Climate of the Past. A special thank for the valuable suggestions helping to improve the manuscript.

Biome reconstruction result is presented but not quantitative climate reconstruction. The late Pliocene/early Pleistocene climate is here rather reconstructed in a qualitative way. In my opinion, climate reconstruction (MTWM and PANN) presented in Tarasov et al. and Brigham-Grette et al., should also be illustrated here.

Basically it is very easy to copy the figure 7 from our publication Tarasov et al 2013 in this issue and put it to our publication as an additional figure. But please take in consideration that that paper Tarasov et al belongs to the same special issue and very easy available for the readers. We tried to avoid such duplications. The papers published in the special issue reflect the different questions concerning the results of different studies of the Lake El'gygytgyn sediment cores. The idea of the special issue is that every article presents original results and as less as possible duplicates results of the other papers. The main focus of our manuscript is vegetation changes reflected in pollen spectra. We decide to change the title of the manuscript to Late Pliocene and early Pleistocene vegetation history of the north-eastern Russian Arctic inferred from the Lake El'gygytgyn pollen record. The new title will better fit the manuscript content while climate and biome reconstructions are presented in other paper. It is simply not easy to put and discus all results to one paper.

*Which follow is a observation I made that could be considered. It starts from the reading of Tarasov et al. and Brigham-Grette et al. papers and your nMDS results (Figure 5). (1) From both published papers, a marked change is evidenced in both biome and climate records at ca. 2.7 Myr BP. In the biome record, we note that before

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2.7 Myr BP tree populations were abundant on the landscape and that afterward it is rather arctic tundra vegetation that dominated the landscape. In the climate record, a notable decrease in annual precipitation (PANN) is evidenced at ca. 2.7 Myr BP as well as an onset of cold winter temperatures. Brigham-Grette et al. (2013) suggested this climate change could illustrate the climatic impact of large Northern Hemisphere ice sheets on the Arctic basin and Beringia obtained with preliminary model simulations. In the MIS stratigraphy, 2.7 Myr BP corresponds to MIS G7/G6 transition.*

The MIS stratigraphy is now added to the figure 3 that will help to read the paper. The additional samples from this interval were also studied for pollen making the changes revealed in the spectra even more distinguishable.

(2) In your pollen record, ca. 2.7 Myr BP corresponds to PZ-19/PZ-20 transition. The first axis of nMDS analysis (Figure 5) separates tree taxa (right side) from herbaceous taxa (left side) placing most shrub in between. Lower PZ (1 to 19), prior to 2.7 Myr BP, have mainly position scores on axis 1 and upper PZ (20 to 53) have negative scores. A stratigraphic plot of axis 1 nMDS sample scores would summarize the main trend in your pollen record and then allow a comparison between the palynostratigraphy and biome and climate results.

We will present the nMDC 1 and 2 axes scores in a stratigraphic plot.

*(3) For myself and because I have a lot of interest in the relationship between pollen, vegetation and climate variability, I calculated some statistics... From ca. 3.6 to 2.7 Myr BP (ca. 900 ka), there is 36 MIS and 19 PZ. PZ averaged 44±34 ka in duration. From ca. 2.7 to 2.2 Myr BP (ca. 500 ka), there is 27 MIS and 34 PZ. PZ averaged 17±6 ka in duration. We all know that a change in pollen assemblage (i.e. transition from one PZ to another) is not always translated by a vegetation change. The pollen content of two PZ could be different but their vegetation (or biome) could be comparable. Despite this, the Lake El'gygytgyn pollen record seems to suggest that vegetation changed less frequently (or was more stable) than global climate before 2.7 Myr BP,

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than afterward, i.e. in early Pleistocene. In early Pleistocene, the vegetation was a tundra but its composition changed frequently (34 PZ in comparison to 19 PZ berore 2.7 Myr). For that period, changes in del 18O composition of benthic foraminifera were however more drastic than before (Lisiecki and Rayno, 2005) and this could explain why the compostion of arctic tundra vegetation changed more frequently. Arctic herbs and shrubs are more vulnerable than for example coniferous trees to climate change. Maybe all this could be discussed? If you illustrate on a same figure the PZ stratigraphy along with the MIS number and the global marine isotope stack what I discussed above will be best evidenced.*

We will certainly interested to improve our knowledge about the changes happened during the Pliocene/Pleistocene transition. Moreover, the next step of our pollen studies is much higher resolution for the interval 2.7-2.5 Ma. When this work will be completed we will conduct further reconstruction of climate and cyclicity changes for this interval and other time slices. This work is still in the progress at the moment. It is also very important to compare our pollen record with environmental changes revealed in the upper (Pleistocene) part of the sediment cores. However the palynological study of this part is also not completed. Any way it is a bit preliminary to state that PZ in during the Early Pleistocene are averaged 17$\pm$6 ka in duration, if you look to the zonation more carefully you may see that duration of many PZ is more likely 10-12 ka. We are simply cannot solve all appearing questions in one publication, especially taking in consideration that the study is still in progress. Any way we will use your suggestions to improve the manuscript quality.

*SPECIFIC COMMENTS: (1) Introduction * Page 4604, lines 6-9. “General geographical information concerning the geology, modern climate and vegetation cover of the study area has been described in Andreev et al. (2012) as well as other papers in this special issue and therefore is not repeated in the current paper.” OK, but I suggest you to at least add a short description on what is the palynological signature of Holocene samples. In comparison to late Pliocene and early Pleistocene record, Pinus

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and Larix pollen grains on Holocene sediments are less abundant and Cyperaceae pollen percentages are higher.*

We do not compare our Pliocene and early Pleistocene spectra to the Holocene ones. Other words, they are certainly not a basis of our vegetation reconstruction. However, such Holocene spectra are well discussed in Andreev et al. (2012), Lozhkin and Anderson (2013), and Tarasov et al. (2013). The modern pollen spectra are also published and discussed in Tarasov et al. 2013. All papers belong to the special issue and very easy available for the reader interested in El'gygytgyn palynology, but we would like to avoid discuss it in our manuscript as they are not directly related to the presented results and avoid the duplication.

*(2) Results * The late Pliocene/early Pleistocene palynostratigraphy of the Lake El'gygytgyn sediment record is described in details. All 53 pollen assemblage zones (PZ) are described! Is it necessary? Furthermore, the pollen content of the PZ is afterward described again on the discussion section (Part 4). Maybe give the description of the 53 PZ summarily on a Table??*

We believe that description of pollen zones have to be presented, but not in details, and we are tried our best to keep the description as short as possible. Please take in consideration that we are describing the exceptionally long pollen record dated between 3.58 and 2.15 Ma. Other word we have the almost 1.5 Ma records with about 940 samples studied now for pollen and non-pollen-palynomorphs which are combined now into 58 pollen zones reflecting changes in vegetation cover and climate. Such description is very important as it provides a basis for the further reconstructions and discussions presented in this special issue and, therefore cannot be excluded from the manuscript. However, the reader may not follow pollen zones details and may look to the description if necessary to confirm our interpretation. Actually, we also thought about a table, however if you try to put 58 pollen zones, their IDs, ages, depths in one table and try to put even a few key words about their pollen contents it will results in several pages table. And in fact such table became even more complicated to follow.

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* In the present paper, 53 PZ have been recognized. In Brigham-Grette et al. (2013) (Figure S6), 40 PZ are illustrated. Why? The pollen analysis was not fully completed at that time?*

Yes, we are tried our best to complete the record since the manuscript by Brigham-Grette et al. was summited to Science on 20 November 2012. There are 7310 samples available for pollen studies and in order to fully complete the records we still need time.

(3) Interpretation and discussion The 53 PZ have been grouped and environmental conditions are discussed for 29 periods. These 29 periods come from where? They are based on what? For myself, I illustrated them on your Figure 3 and I do not undestrand more on what they are based: : : Adding a sentence explaining that would be appreciated.

We are tried to group the reconstructed changes into suitable time slices but not always to periods connected to some global environmental changes. We will add an explanation.

Quantitative climate reconstructions have been done on this late Pliocene/early Pleistocene pollen record and results are published (Brigham-Grette et al., 2013 and Melles et al., 2012). In the current paper, climate interpretation of the pollen record is mainly discussed in a qualitative way (for example, warm and wet or cold and dry). I do not understand why quantitative results were not taken into account and that results are not illustrated.

The quantitative climate reconstructions are already presented in papers by Brigham-Grette et al. (2013) in Science and Tarasov et al. (2013) this issue. They are certainly were taken in account but as they well illustrated in closely connected paper by Tarasov et al. and easy available we do not repeat them in this manuscript.

*Along the text, you always associated a warmer climate to wetter hydrographic condions and colder climate to drier conditions. Pliocene climate has never been warm

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and dry or cold and wet?*

It is not easy to say about the entire Pliocene basing on our data but according our reconstruction never in the area during the studied interval. For details please see Tarasov et al. (2013) this issue.

The PZ are frequently discussed in light of the MIS stratigraphy. However, MIS numbers are not indicated on your figures. We must always look at other publications to follow you, notably those of Tarasov et al. (2013) and Brigham-Grette et al. (2013).

Added now.

In the text, when you refer to pollen grains, sometimes you talk about “pine pollen” and other times about “Pinus pollen”. Maybe use latin names when you talk about pollen abundance in the PZ (e.g., increase in Pinus pollen) and common english names of the taxa only when you talk about vegetation on the landscape (e.g., dense stone pine communities).

Agree. We will follow your advice.

* Page 4619, line 14. “: : : confirm that open habitats were common in the study area.” This is clearly illustrated with the landscape openess curve illustrated on the Fig 7B of Tarasov et al. (2013). Adding this curve on you figure 6, along with biome reconstruction, would help to best understand your discussion.*

The idea of the special issue is that every article presents original results and as less as possible duplicates results of the other papers. In this case as in several others we would like to retain from duplication of the mentioned curve and refer instead to original paper of Tarasov et al. (2013) published in the same issue.

* Page 4624, lines 17-18. “Around 3.025 Myr contents of birch and alder shrub pollen significantly decrease in the spectra BP (PZ-13), while pine, spruce and larch ones increase.” What is the spectra BP? Pinus pollen percentage indeed increased from PZ-12 to PZ-13 but not Picea and Larix pollen abundance. If yes, this is not clearly

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evidenced on the pollen diagram. For me, the percentage of these two taxa in PZ-12 and PZ-13 looks like comparable.*

The mistyping will be corrected.

* Page 4625, lines 18-19. “After 2.91 Myr BP (PZ-16) further increases in coniferous, Cyperaceae and Ericales pollen percentages reflect that the climate conditions became wetter and warmer.” I agree, this assemblage could be interpreted as warmer conditions, but wetter: : :? Add a reference that link an increase in these taxa with wetter conditions. An increase in Cyperaceae pollen could indeed be associated with wetter conditions but coniferous and Ericales pollen?*

Will be corrected.

* Page 4625, lines 20-21. “The climate amelioration is also suggested by an increase in the long-distance transported pollen influx.” I do not follow you... Precise how an increase in long-distance pollen grains can be interpreted as a climate amelioration. If thermophilic pollen grains are more abundant in the assemblages (here PZ-16) than before (PZ-15), I could be in agreement with you.*

Will be corrected.

* (4) References Could you please give a reference that link high Botryococcus abundance with lower water-level and drier climate? Here is one: Andreas Clausing (1999) Palaeoenvironmental significance of the green alga Botryococcus in the lacustrine rotliegend (upper carboniferous âËŸAËĞR lower permian), Historical Biology: An International Journal of Paleobiology, 13:2-3, 221-234, DOI: 10.1080/08912969909386582*

Thanks, we will provide the reference.

* (5) Figures Figure 5. At first sight, this figure is difficult to understand. We must look carefully at it. Maybe illustrate PZ 1 to 19 in a different way?? (see my general comments).*

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We will extend the figure caption to indicate what is presented in the figure. Still, we think that this figure best summarizes the major data structure of the data set i.e. the relationship among taxa, the similarity among the various pollen zones and the compositional characteristics of the various pollen zones.

* Add a synthesis figure that compare all results based on pollen data? This figure could replace to the current Fig. 6, which is from Tarasov et al. (2013). You could use the Fig. 7 of Tarasov et al., published in the same issue of Climate of the Past, and add to it (a) PZ numbers and (b) stratigraphic plot of axis 1 nMDS sample scores (see my general comments). The stratigraphic plot will clearly illustrate the late Pliocene/early Pleistocene transition (ca. 2.7-2.6 Myr BP) in the pollen record. You could also illustrate on this figure the 29 periods used in the discussion. In my opinion, the comparison of the PZ chronology with the MIS one could be very interesting. Is there a synchronicity or not between both stratigraphical results? What is the relationship between vegetation and climate variability through late Pliocene/early Pleistocene in north-eastern Russian Arctic? Illustrate together all results discussed in the paper will add strong value to the manuscript.*

Well, please take in consideration that this manuscript is focusing mainly on the vegetation changes but not to the comparison of all results based on pollen data. It is simply not possible to discuss all arising questions in frame of one manuscript. Moreover, the relationship between vegetation and climate variability through late Pliocene/early Pleistocene in north-eastern Russian Arctic is well discussed in the closely related paper by Tarasov et al. this issue and easily available for the interested reader we would not like to copy the Fig. 7 from that paper and put it in this manuscript. We would prefer to refer instead. Also the further statistical treatment of the pollen dataset will be conducted and a paper by Herzschuh et al. especially devoted to these results is in preparation and will be submitted soon.

TECHNICAL CORRECTIONS:

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Thank you very much for all technical corrections. We will change the text accordingly.

Interactive comment on Clim. Past Discuss., 9, 4599, 2013.